Chemical Agent Resistant Coatings Status Update

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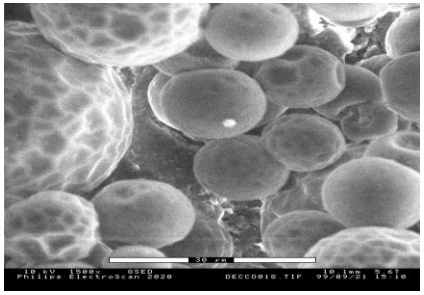
Courtesy of U.S. DoD



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Outline

Courtesy of U.S. Army

- ***Who we are & What we do……***
- ***Key areas of Interest and efforts***
  - ❖ ***Topcoats, Primers, Pretreaments and Munitions***
- ***Water Dispersible & Solvent Based Chemical Agent Resistant Coatings (WD-CARC & Moisture Cure CARC)***
- ***Next Generation of Coatings***

Courtesy of U.S. DoD

Who we are…..

- ARL is the Lead DOD R&D Activity for CARC
  - ➢ Innovative formulations approaches
  - ➢ New raw materials selections
  - ➢ Advanced characterization

- Maintains Ownership for all key specifications regarding pretreatments, primers and topcoats for all tactical and related support equipment and munitions coating

❖ Elements assist to implement and transition products

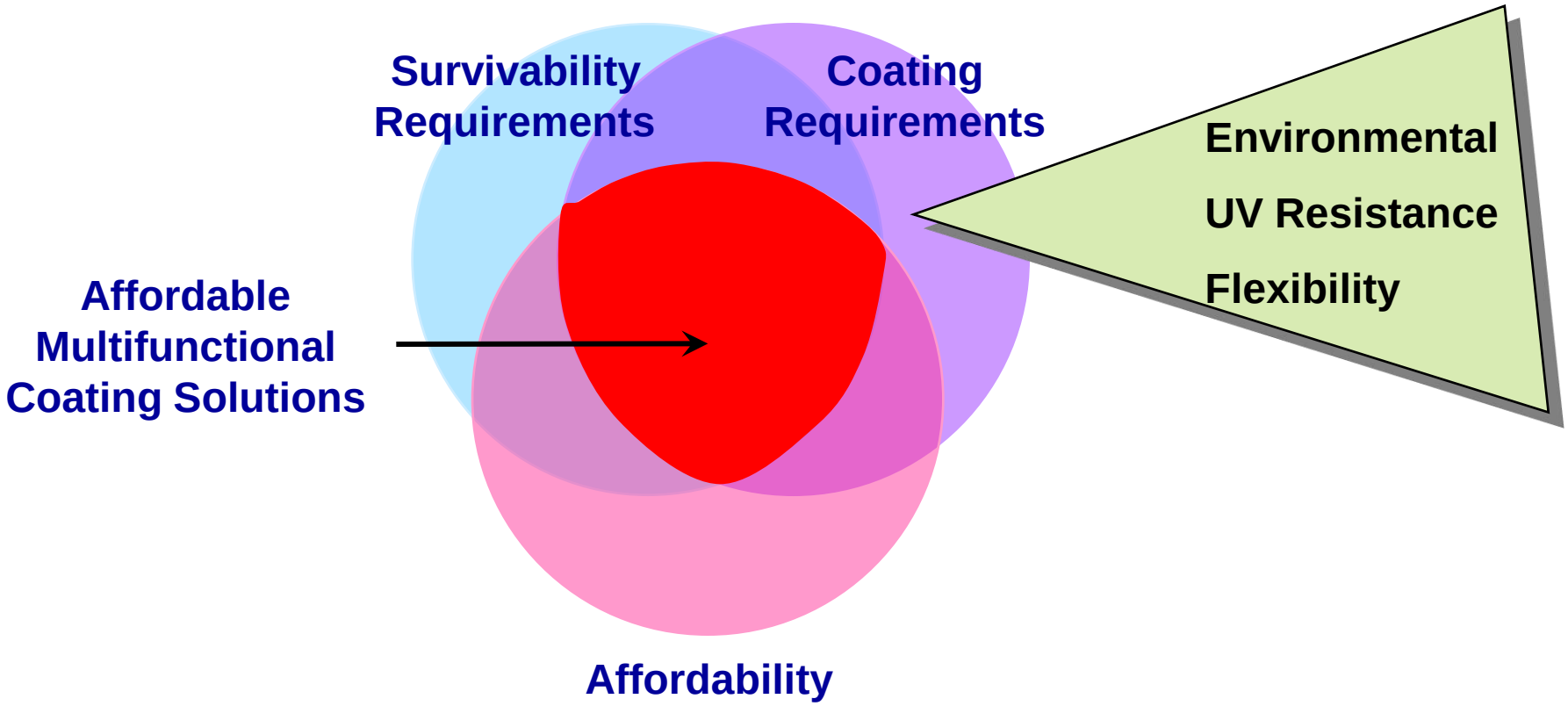
Guiding Principles for Coating Systems

Environmental ⟷ **Survivability**

Durability

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Increased Options for Balanced Requirements



New coatings formulations
More Survivable and Durable Platforms

What we do…

- Develop materials for military unique coatings including pretreatments, primers, and topcoats
  - Chemical Agent Resistant Coatings
  - Munitions coatings
  - Industrial coatings for vehicle interiors

- Produce materials that balance three critical requirements
  - Survivability (camouflage, chemical agent resistance)
  - Durability (appearance, corrosion, compatibility, etc.)
  - Environmental compliance and pollution prevention

- Implement and transition new products
  - Specifications and Standards
  - Troubleshooting, consulting, and problem solving

- Analyze and solve technical problems related to coatings systems used on Army Materiel

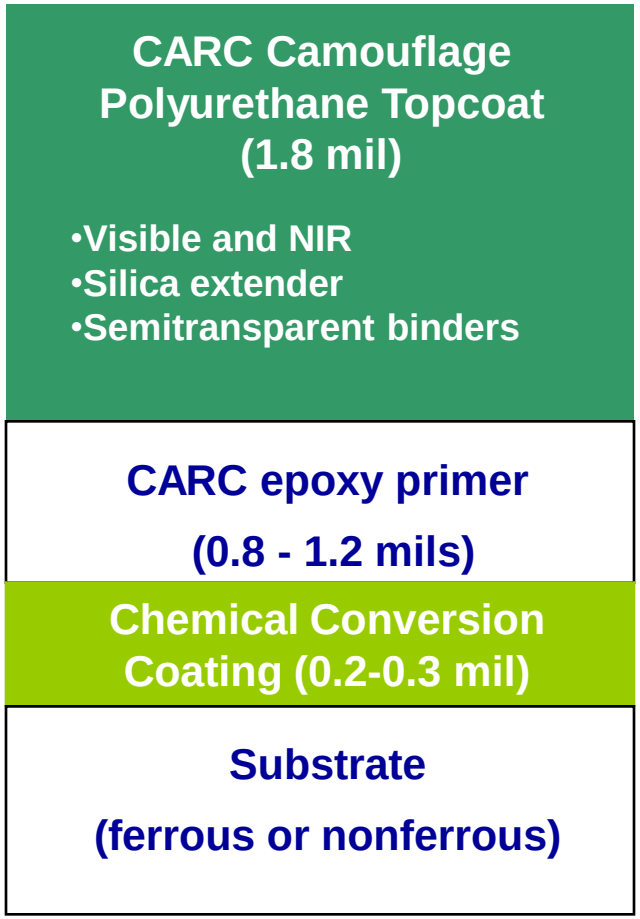
New Paradigm in Coatings

- Recent Coatings represent superior durability, environmental compliance
- Stereotypes associated with Emulsions, Water Based or Hexavalent Chromium Free chemistries no longer hold true
- Current efforts establishes solid foundation for present and future survivability enhancements and multifunctional capabilities
- ARL has eliminated standard coatings used and are implementing a new generation of coating technology throughout DOD

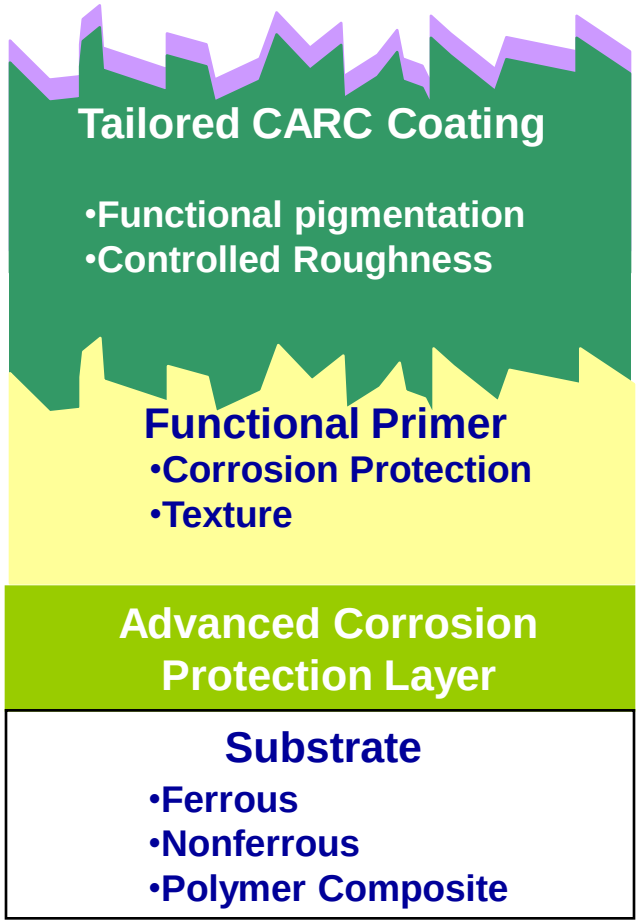
CARC as a System

Hierarchical Architecture of Multifunctional Coatings

Today

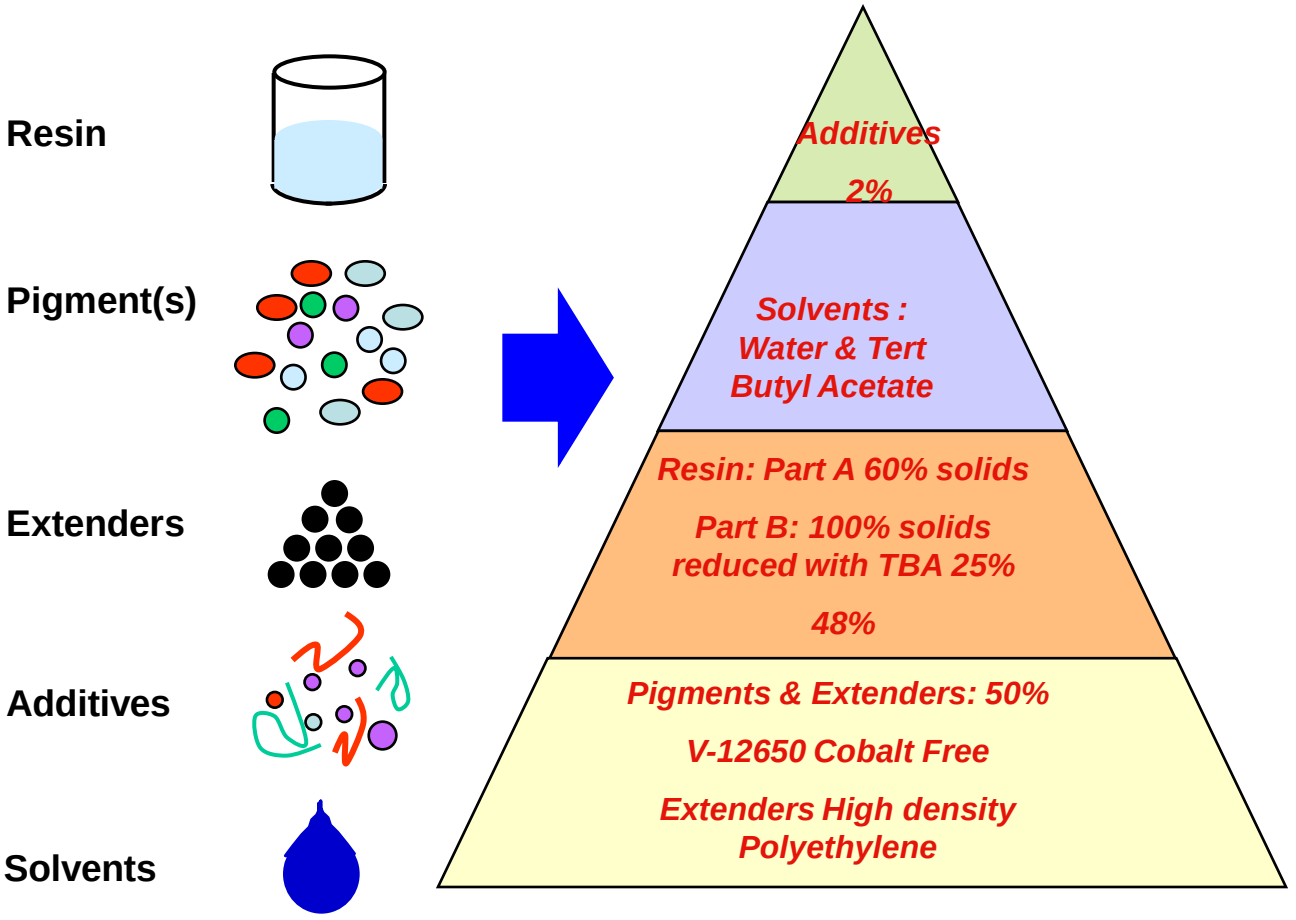


Tomorrow



Raw Material Selection and Design

Individual Coating Components



Core Interests for Coating Development

- ✓ Hexavalent Chrome Free Pre-Treatments
- ✓ Zinc Phosphate Alternatives for Ferrous
- ✓ Low Solar Absorbing and Insulative
- ✓ Reactive or self decontaminating
- Super hydrophobic & olephobic coatings
- UV cured coatings
- Powder coat (Primer and Topcoat)
- Anti-skid CARC
- High Temperature Resistant
  - Intumescent types

Cr6+ Free Pretreatment for DoD Applications

- Mandated for all tactical and support platforms
- Free of hexavalent chromium (Cr 6+)
- No volatile HAPs
- Ease of application using existing infrastructure
- Equal or better corrosion performance to current Cr 6+ wash primers
- Broad substrate/topcoat compatibility
- Cost effective

Cr6+ Free Pretreatment for DoD Applications

Multi-Substrates:

- Steel 1010, 1008
- Galvanized steel
- Stainless steel
- Al 2000/5000/6000/7000 series
- Ceramic/Composite

- **Coating:** must be compatible with existing military topcoats and primers
  - Three vendors have responded with products
  - SERDP effort with PPG & ARL for Zinc Phosphate Alternative

- **Process:** Depot and Repair

Low Solar Absorbing CARC

- 2 year weathering excellent: Less than 1 color unit change
- Formulated four Primary Colors
- IR requirements will shift from 380nm -900nm to 380nm-2000nm with emphasis on 750nm to 1700nm.
- Visible unchanged
- Key highlight: COST, cobalt spinal increase of 300% and availability erratic
- Formulation will be cobalt free for 383 Green, AC Green, 383 Brown
- 383 Green to change to 808 Green to identify change
- Open to other approaches*

Coatings For Munitions Technology

Purpose

- Provide capability for new or existing coatings to improve munitions response to IM (Insensitive Munitions) threats

Result

- Coating formulation and technologies for IM design
- Demonstration of integrated technologies for improved IM behavior in packaging and missiles.

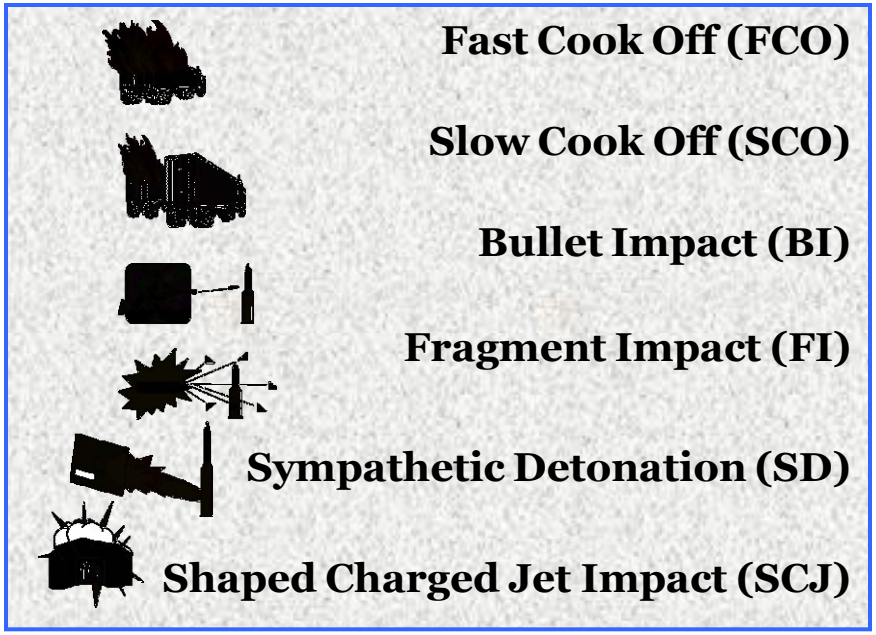
Payoff

- Improved tactical and combat system survivability
- Reduced transportation and storage burden
- Transition technologies

Coatings For Munitions Technology

OBJECTIVE:

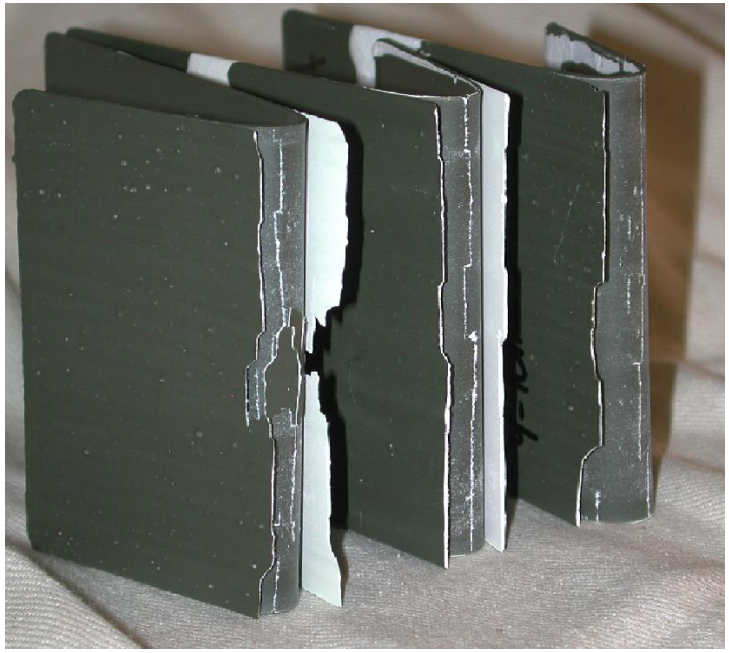
- **Develop coatings with improved thermal protection**
- **Demonstrate coatings to enable a controlled burn and prevent violent reaction**



TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Technical Challenge

- Paint delamination
  - Cracking and chipping
  - Rough Handling – esp. at extreme temp
- Impact resistant
- Flexibility
- Moisture resistance
- Material compatibility
- Cost



Coatings For Munitions Technology

Technical Thrusts

Coating Development- all munitions that require thermal control

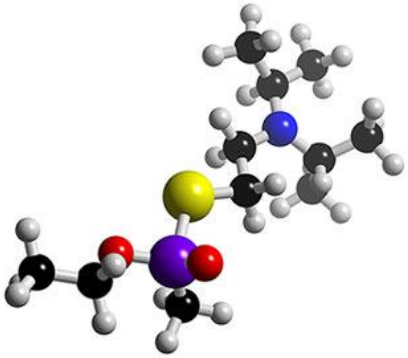
IM Performance

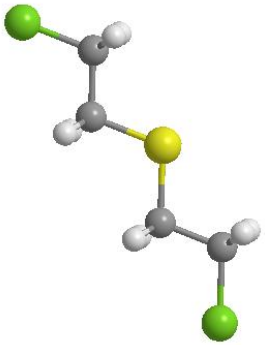
- Mechanical properties (-65 to 165°F)
- Blast protection
- Thermal protection

≡ Survivability
≡ Readiness

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

Self-Decontaminating Coatings : DTRA





First Generation Coatings

TECHNOLOGY DRIVEN. **WARFIGHTER FOCUSED.**

DTRA Self Detoxifying Surfaces Team

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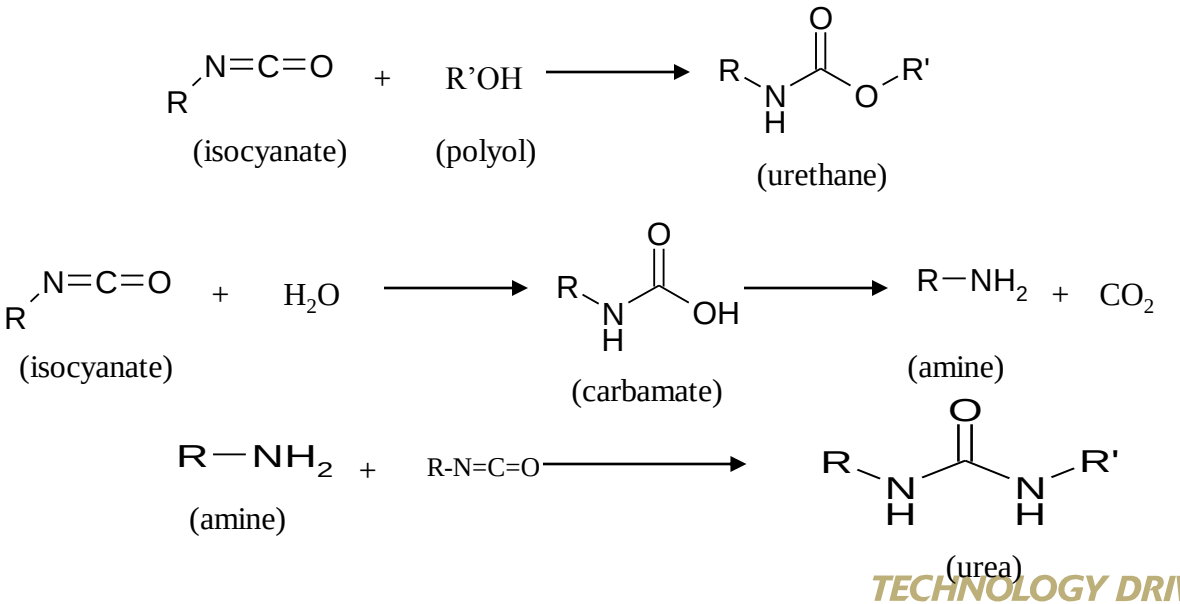
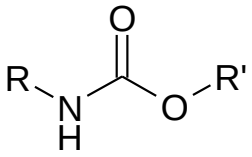
Topcoat Formulations

- **New Polyols**
  - **Completely water soluble, no co-solvents needed**
- **Tert-butyl acetate (VOC exempt) to dissolve and disperse isocyanate**
- **Attempt to reduce NCO:OH indexing to reduce solvent content**

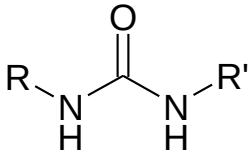


Role of Polyurethane

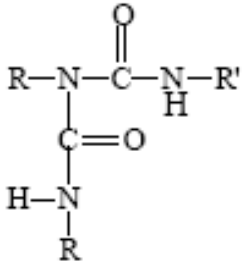
- Unacceptable CAR at NCO:OH < 4
- NMR and FTIR to measure quantify ratio of side products vs. NCO:OH ratio
- Adjust additives, reaction conditions, etc.
  - to make more favorable distribution



Urethane

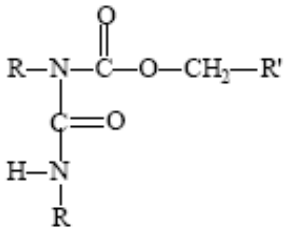


Urea



Biuret

(Urea + isocyanate)

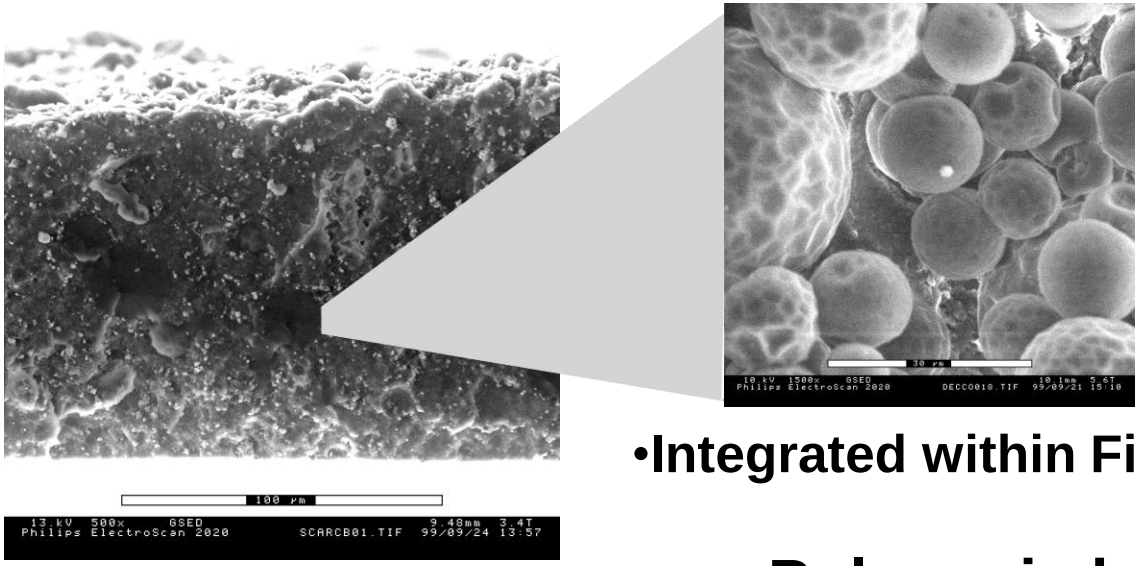


Allophanate

(Urethane + isocyanate)

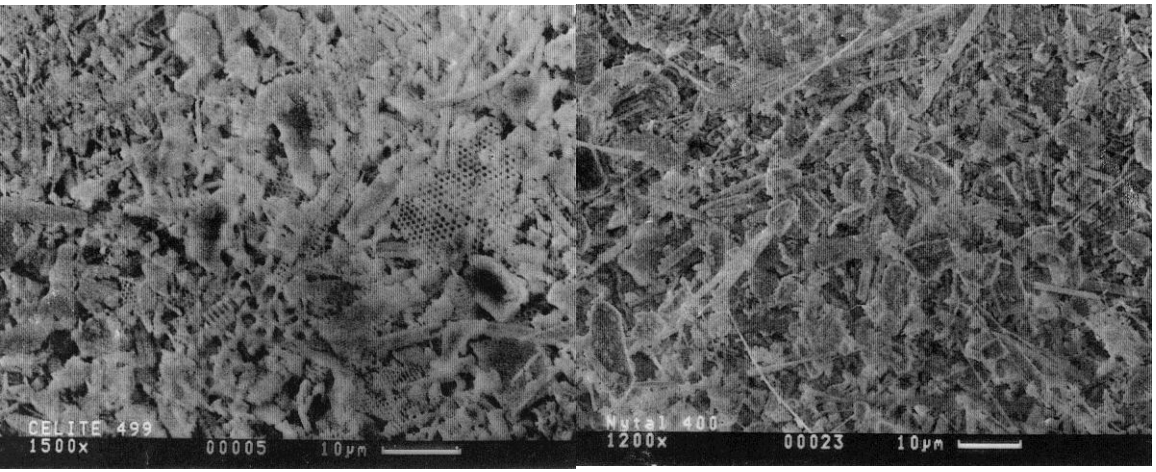
Pigments/Extenders

Polymeric beads



- **Integrated within Film**

- **Polymeric beads**
  - **Reduce chalking effect**
  - **Improve UV resistance**
  - **Improve performance**



Diatomaceous silica

Talc

The Details

- Development and implementation of Water-Dispersible and Moisture Cure CARC System– affects 3 million gallons of paint annually
  - 2.3 Million Topcoat & approximately 1 million in Primers
  - New Generation CARC topcoat: enhanced flexibility and UV resistance.
  - Elimination of Hazardous Air Pollutants from existing primers

- Low Solar loading pigmentation development
  - Reduce temperature build up on military assets
  - Prolong service life of coating
  - Enhance camouflage capabilities

MIL-DTL-53039

- New types to include 1.0, .5 and zero VOC (Lbs/gal) with zero HAPs flattened with non-silica based raw materials.
- Inclusion of 34201 color (Woodland Desert Sage) . Currently used on CH-47
- Elimination of reference to MIL-T-81772 Aircraft Thinner (100% VOCs)
- Allowing vendors to provide exempt solvent package

CARC -Touch up Kits

- **Touch up Kits –QPL Specifications as TYPE III- Self Contained Kits**
  - **Aerosol**
  - **Roller**
  - **Brush**
  - **Cartridge**

VENDORS: Hentzen Coatings

MILSPRAY/Spectrum

Sherwin Williams

Technology and Commercial Applications

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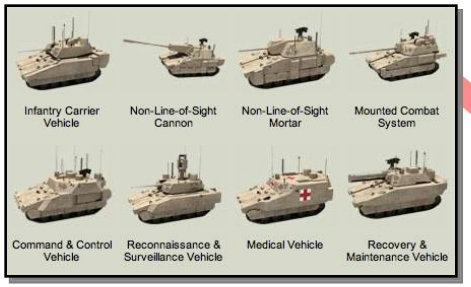
Technology and Commercial Applications

Corrosion Resistant Materials for Armor

Aluminum Alloy 5059 For Armor Applications Foreign Comparative Test Program

- Updated military Al armor specification MIL-DTL-46027K
- Over $14M to date in acquisition
  - $12M+ in direct procurement of AA5059 for RG-33 MRAP
  - Over $1.1M of acquisition by OEMs for internal testing, design, and prototyping
  - AA5059-H131 chosen as primary (100%) common hull material for all 8 variants of the PM FCS-BCT Manned Ground Vehicle (MGV) by Boeing (LSI), General Dynamics, and BAE Systems

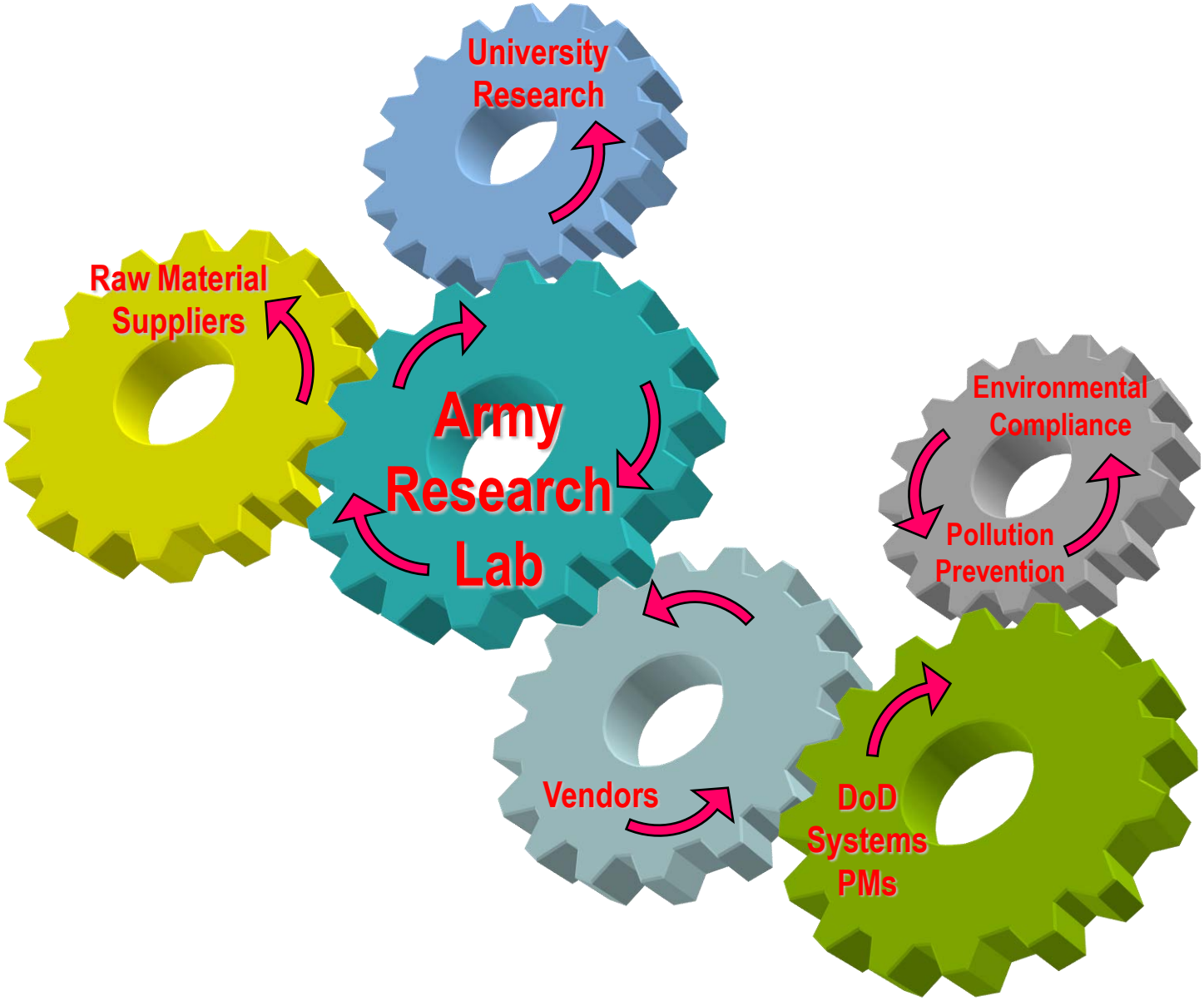
MRAP RG-33



(8) MGV Mission Based Variants

- Related work - military specification MIL-DTL-32262 created for 6061 Al

Synergistic Interaction for Maximum Impact



New Generation of Coatings

- **Survivability**
  - ➢Topcoat Agent & Bio Resistant
    - ➢Passive: completely inert
    - ➢Active: self-decontaminating
  - ➢Appearance
    - ➢Functional pigmentation and extenders
    - ➢Controlled surface morphology
- **Durability**
  - ➢UV resistant
  - ➢Enhanced Corrosion resistant
- **Environmental Compliance**
  - ➢Water Dispersible resins/Low VOCs
  - ➢Elimination of Hazardous Air Pollutants
  - ➢Polymeric Flattening agents used for all topcoats